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10/596,022	05/25/2006	Toshiharu Furukawa	FIS920030339US1	1812

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EXAMINER	
GEBREYESUS, YOSEF	

ART UNIT	PAPER NUMBER
2811	

NOTIFICATION DATE	DELIVERY MODE
03/08/2010	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

EFIPLAW@US.IBM.COM

Office Action Summary	Application No.	Applicant(s)	
	10/596,022	FURUKAWA ET AL.	
	Examiner	Art Unit	
	YOSEF GEBREYESUS	2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *14 January 2010*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *25 May 2006* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 01/14/2010 has been entered.

Information Disclosure Statement

2. The information disclosure statement (IDS) submitted on 5/22/2006 is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Specification

3. The specification is objected to as failing to provide proper antecedent basis for the claimed subject matter. See 37 CFR 1.75(d)(1) and MPEP § 608.01(o). Correction of the following is required: Claim 1 on line 4, claim 2 on line 4 recite the limitation, "**multiple** conductive carbon nanotubes". This limitation is not disclosed in the written description. Specifically, the drawing does show the feature, but the written part of the specification does not disclose the limitation "multiple".

4. The specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Claim Objections

5. Claims 3, 5, 7-10, 11-17 are objected to because of the following informalities:

6. Claim 3 on line 2 recites the limitation "carbon nanotubes" which appears to be "multiple conductive carbon nanotubes".

7. Claim 3 on line 3 recites the limitation "conductive carbon nanotubes" which appears to be "multiple conductive carbon nanotubes".

8. Claim 5 on line 1 recites the limitation "conductive carbon nanotubes" which appears to be "multiple conductive carbon nanotubes".

9. Claim 7 on lines 2-3 recites the limitation "carbon nanotubes" which appears to be "multiple conductive carbon nanotubes".

10. Claim 8 on line 3 recites the limitation "conductive carbon nanotubes" which appears to be "multiple conductive carbon nanotubes".

11. Claim 9 on lines 1-2 recites the limitation "conductive carbon nanotubes" which appears to be "multiple conductive carbon nanotubes".

12. Claim 10 on line 2 recites the limitation "carbon nanotubes" which appears to be "multiple conductive carbon nanotubes".

13. Claim 11 on line 3 recites the limitation "said trench" which appears to be "said one trench".

14. Claim 11 on line 4 recites the limitation "carbon nanotubes" which appears to be "conductive carbon nanotubes".

15. Claim 15 on line 1 recites the limitation "carbon nanotubes" which appears to be "conductive carbon nanotubes".

16. Claim 17 on line 2 recites the limitation "carbon nanotubes" which appears to be "conductive carbon nanotubes".

17. Appropriate correction is required.

Claim Rejections - 35 USC § 112

18. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

19. Claim 12 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

20. Claim 12 recites the limitation "said layer of trench dielectric" in lines 2-3. There is insufficient antecedent basis for this limitation in the claim.

21. Claim 12 recites the limitation "said bottom of said trench" in line 3. There is insufficient antecedent basis for this limitation in the claim.

22. For the purpose of below examination, the examiner has interpreted "said layer of trench dielectric" to mean "a trench dielectric", "said bottom of said trench" to mean "a bottom of said trench".

Claim Rejections - 35 USC § 103

23. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

24. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

25. Claims 1-3, 6-8, 10-11, 14-15 and17-19, as best can be understood .are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al. (US 2004/0043629, dated March 4th, 2004, filed August 29th, 2002) in view of Lee et al. hereafter "Lee" (US 2002/0048143, dated April 25th, 2002, filed March 15th, 2001).

26. Regarding **claim 1**, figure 1A-1F and related text of Lee et al. discloses a substrate 110; a trench in said substrate; conductive material 115 (paragraph [0021]) lining said trench; and a trench conductor (conductive electrode) 119 (paragraph [0023]), surrounded by said conductive material filling said trench (paragraph [0022]), wherein said trench conductor (conductive electrode) 119 (paragraph [0023]) and said substrate 110 having a co-planar top surface.

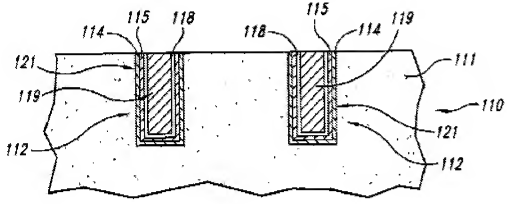

Fig. 1F

Lee et al. does not disclose the conductive material is a multiple conductive carbon nanotubes.

However, in the same field of endeavor figure 1 of Lee teaches using multiple conductive nanotubes 100 as a capacitor electrode (paragraph [0024]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to replace the conductive material 115 of Lee et al.'s device with multiple carbon nanotubes as taught by Lee in order to increase the storage capacity of the capacitor (paragraph [0006]).

27. Regarding **claim 2**, figure 1A-1F and related text of Lee et al. discloses a substrate 110; at least one trench in said substrate; conductive material 115 lining said at least one trench; a trench conductor (conductive electrode) 119 filling said trench; and a trench dielectric (under layer, tantalum oxide) 114 (paragraph [0014] & [0023])

between said conductive material 115 and sidewalls of said trench and directly underneath and in contact with said conductive material 115.

Lee et al. does not disclose the conductive material is a multiple conductive carbon nanotubes.

However, in the same field of endeavor figure 1 of Lee teaches using multiple conductive nanotubes 100 as a capacitor electrode (paragraph [0010] and [0024]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to replace the conductive material 115 of Lee et al.'s device with multiple carbon nanotubes as taught by Lee in order to increase the storage capacity of the capacitor (paragraph [0006]).

28. Regarding **claim 3**, figure 1A-1F Lee et al. and Figure 1 of Lee disclose a layer of trench dielectric 114 & 118 on top of a bottom of said trench and between said carbon nanotubes (conductive material) 115 and sidewalls of said trench, wherein the conductive carbon nanotubes (conductive material) 115 form an open cylinder structure lining said sidewalls of said trench through said layer of trench dielectric 114.

29. Regarding **claim 6**, figure 1A-1F and related text of Lee et al. discloses the substrate 110 is free of carbon nanotube catalyst materials (the substrate is formed of silicon dioxide) (paragraph [0014]).

30. Regarding **claim 7**, figure 1A-1F Lee et al. and Figure 1 of Lee disclose the carbon nanotubes (conductive material) 115 form a consistent lining along approximately the entire length of sidewalls of said trench.

31. Regarding **claim 8**, figure 1A-1F Lee et al. and Figure 1 of Lee disclose the trench-type storage device is planarized so that a top surface of the substrate 110 is coplanar with respective top surfaces of the trench dielectric 114, the conductive carbon nanotubes (conductive material) 115 and the trench conductor (conductive electrode) 119.

32. Regarding **claim 10**, figure 1A-1F Lee et al. and Figure 1 of Lee disclose a trench dielectric 114 between said carbon nanotubes (conductive material) 115 and sidewalls of said trench.

33. Regarding **claim 11**, figure 1A-1F and related text of Lee et al. discloses a substrate 110; one trench in said substrate 110; conductive material 115 forming an open cylinder in lining said trench; and a trench conductor (conductive electrode) 119 (paragraph [0023]) filling said open cylinder of said conductive material 115, wherein said trench conductor 119 and said substrate 110 having a co-planar top surface.

Lee et al. does not disclose the conductive material is a multiple conductive carbon nanotubes.

However, in the same field of endeavor figure 1 of Lee teaches using multiple conductive nanotubes 100 as a capacitor electrode (paragraph [0010] and [0024]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to replace the conductive material 115 of Lee et al.'s device with multiple carbon nanotubes as taught by Lee in order to increase the storage capacity of the capacitor (paragraph [0006]).

34. Regarding **claim 14**, figure 1A-1F and related text of Lee et al. discloses the substrate 110 is free of carbon nanotube catalyst materials (the substrate is formed of silicon dioxide) (paragraph [0014]).

35. Regarding **claim 15**, figure 1A-1F Lee et al. and Figure 1 of Lee disclose the carbon nanotubes (conductive material) 115 form a consistent lining along approximately the entire length of sidewalls of said trench.

36. Regarding **claim 17**, figure 1A-1F Lee et al. and Figure 1 of Lee disclose a trench dielectric 114 between said carbon nanotubes (conductive material) 115 and sidewalls of said trench.

37. Regarding **claim 18**, figure 1A-1F Lee et al. and Figure 1 of Lee disclose a trench dielectric layer 114 directly underneath said multiple conductive nanotubes (conductive material) 115.

38. Regarding **claim 19**, figure 1A-1F Lee et al. and Figure 1 of Lee disclose wherein said trench dielectric layer 114 lining at least a substantial portion of sidewalls of said trench and said multiple conductive nanotubes (conductive material) 115 lining said trench via said trench dielectric layer 114.

39. Claim 4-5, 12-13 and 20 ,as best can be understood, is rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al. (US 2004/0043629, dated March 4th, 2004, filed August 29th, 2002) and Lee et al. hereafter "Lee" (US 2002/0048143, dated April

25th, 2002, filed March 15th, 2001) further in view of Widmann et al. (US 2001/0012658, dated August 9th, 2001, filed April 14th, 2001).

40. Regarding **claim 4,** figures 1A-1F and related text of Lee et al. disclose wherein the trench conductor 119 comprises a conductive electrode contacting said layer of trench dielectric 118 on top of said bottom of said trench.

Lee et al. and Lee do not disclose the trench conductor material is polysilicon.

However, in the same field of endeavor, figure 3 of Widmann et al. discloses forming a trench conductor 22 with polysilicon material (paragraph [0035]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the combination of Lee et al.'s and Lee's device conductive electrode with polysilicon material as taught by Widmann et al. because such material is conventional and known in art to form storage device conductors.

41. Regarding **claim 5**, figure 1A-1F Lee et al. and Figure 1 of Lee disclose that the conductive carbon nanotubes (conductive material) 115 and the trench conductor 119 are disposed in the trench.

Lee et al. and Lee do not disclose the trench conductor material is carbon free.

However, in the same field of endeavor, figure 3 of Widmann et al. discloses forming a trench conductor 22 with carbon free (polysilicon material) (paragraph [0035]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the combination of Lee et al.'s and Lee's device conductive electrode with carbon free (polysilicon) material as taught by Widmann et al.

because such material is conventional and known in art for forming storage device electrodes.

42. Regarding **claim 12,** figures 1A-1F and related text of Lee et al. disclose wherein the trench conductor 119 comprises a conductive electrode contacting said layer of trench dielectric 118 on top of said bottom of said trench.

Lee et al. and Lee do not disclose the trench conductor material is polysilicon.

However, in the same field of endeavor, figure 3 of Widmann et al. discloses forming a trench conductor 22 with polysilicon material (paragraph [0035]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the combination of Lee et al.'s and Lee's device conductive electrode with polysilicon material as taught by Widmann et al. because such material is conventional and known in art for forming storage device conductors.

43. Regarding **claim 13,** figure 1A-1F Lee et al. and Figure 1 of Lee disclose that the conductive carbon nanotubes (conductive material) 115 and the trench conductor 119 are disposed in the trench.

Lee et al. and Lee do not disclose the trench conductor material is carbon free.

However, in the same field of endeavor, figure 3 of Widmann et al. discloses forming a trench conductor 22 with (carbon free) polysilicon material (paragraph [0035]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the combination of Lee et al.'s and Lee's device conductive electrode with (carbon free) polysilicon material as taught by Widmann et al.

because such material is conventional and known in art to form storage device conductors.

44. Regarding **claim 20,** figures 1A-1F and related text of Lee et al. and figure 1 of Lee disclose wherein said trench dielectric layer 114 & 118 having a shape, lined by said multiple conductive nanotubes (conductive material) 115 across sidewalls of said shape, and filled by said trench conductor (conductive electrode) 119.

Lee et al. and Lee do not disclose the trench dielectric is formed of cylindrical shape.

However, in the same field of endeavor Widmann et al. discloses trench dielectric is formed of cylindrical shape (paragraph [0014]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the combination of Lee et al.'s and Lee's trench dielectric with cylindrical shape as taught by Widmann et al. in order to increase the surface area of the storage electrode.

45. Claim 9 and 16 rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al. (US 2004/0043629, dated March 4th, 2004, filed August 29th, 2002) and Lee et al. hereafter "Lee" (US 2002/0048143, dated April 25th, 2002, filed March 15th, 2001), and further in view of Yoshikazu Homma ("Growth of suspended carbon nanotube..." dated 09/16/2002, hereinafter Homma et al.)

46. Regarding **claim 9**, figure 1A-1F Lee et al. and Figure 1 of Lee substantially disclose the claimed invention except the conductive carbon nanotubes (conductive material) are grown downwards into the trench.

However,, in the same field of endeavor Homma et al. discloses growing nanotubes downward (page 2263, 5th paragraph).

Therefore, it would have been obvious to one ordinary skill in the art at the time the invention was made to grow down wards, the carbon nanotubes, of the combination of Lee et al.'s and Lee's device, as taught by Homma et al. for the purpose of forming vertical nanotubes without having arches at the top (page 2263 col. 2 lines 15-19).

47. Regarding **claim 16**, figure 1A-1F Lee et al. and Figure 1 of Lee substantially disclose the claimed invention except the conductive carbon nanotubes (conductive material) are grown downwards into the trench.

However, in the same field of endeavor Homma et al. discloses growing nanotubes downward (page 2263, 5th paragraph).

Therefore, it would have been obvious to one ordinary skill in the art at the time the invention was made, to grow down wards, the carbon nanotubes, of the combination of Lee et al.'s and Lee's device, as taught by Homma et al. for the purpose of forming vertical nanotubes without having arches at the top (page 2263 col. 2 lines 15-19).

Response to Arguments

48. Applicant's arguments with respect to all claims (1-20) have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to YOSEF GEBREYESUS whose telephone number is (571)270-5765. The examiner can normally be reached on Monday through Thursday 7:30 to 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lynne A. Gurley can be reached on 571-272-1670. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Lynne A. Gurley/
Supervisory Patent Examiner, Art Unit 2811

/YOSEF GEBREYESUS/
Examiner, Art Unit 2811

02/22/2010